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I have no use for this copy, so I'm fowarding it to you. As I stated before, it sounds quite reasonable, and I'll be glad to back you should you decide to go along with it.

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DATE: January 6, 1967

Proposed Change in Scope
for the GEMS Study Effort

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TABLE OF CONTENTS

1.0 INTRODUCTION

In the course of the performance on the GEMS Study effort, some problems were encountered in the simulation of mission material resolution and contrast. In the simulation process, low resolution and contrast GEMS photographs were produced basically because original negative material with a gamma of 2.3 was being employed to generate GEMS masters.

A tonal scale simulation study indicated that the photographic parameters of contrast and resolution can be improved by employing original negative material that is processed to a gamma of unity. Without further study, it remains questionable whether this unity gamma negative material will yield the desired realistic simulation.

The past two months have been devoted to investigating the problems associated with the simulation process and exploring possible means of modifying the simulation process in order to generate suitable material. Analytically, one modified process has been established to be feasible. Therefore, this report was written to recommend a course of action that will lead to the desired objectives of the program and also lend direction to the ultimate goal of establishing a

diagnostic tool with which to rapidly assess mission material image quality.

2.0 CHANGE IN PROGRAM SCOPE

Ideally, [redacted] would like to establish a course of action that is both suitable to the customer and instrumental to the program's objectives. Such a program scope has been developed and is presented below for your review.

2.1 RECOMMENDED PROGRAM SCOPE

The program scope is to be directed toward determining the utility of GEMS and recommending an appropriate means of simulating mission material. The program objectives are as follows:

(A) Prepare a Psychophysical GEMS matrix by an alternate procedure, and determine the utility of GEMS at the specific photographic parameters of mission material by means of a psychophysical study.

(B) Develop a means of generating equal magnification GEMS to be used in the evaluation of mission material.

(C) Evaluate the system parameters of MTF, contrast, exposure, granularity, and sensitometry in order to specify the GEMS parameters.

(D) Specify a flight program to acquire suitable material with which to generate GEMS if the equal magnification GEMS procedure requires it.

(E) Perform a design concept study aimed at modifying the present GEMS Viewer to establish a Pseudo GEMS Viewer.

2.2 DISCUSSION OF SCOPE CHANGES

It becomes apparent, when reviewing the recommended program scope, that the GEMS Matrix task has been eliminated from the original program objectives. Conducting this phase of the contract, without the prior completion of the items described in section 2.1, would be both undesirable and technically hazardous.

More recent knowledge of image simulation technology indicates that the pseudo GEMS technique may be a more favorable approach to the subjective evaluation of image quality than simulated GEMS photographs. However, it is not possible

to state that either one of the two simulation techniques will yield the program objectives more readily than the other. Therefore, it is recommended that the program activities be directed toward a parallel effort in both the photographic GEMS and Pseudo GEMS technical areas. At the conclusion of this proposed program, the customer would be given a final report that relates the findings of the Psychophysical GEMS study, a description of the developed technical approaches to accomplish simulated photography by both GEMS techniques, and a recommendation as to what GEMS efforts should be continued in order to obtain a finalized evaluation technique.

3.0 DISCUSSION OF RECOMMENDED PROGRAM TASKS

The philosophy adopted to successfully complete the GEMS study program is based on performing a psychophysical GEMS study, resolving the technical problems associated with generating GEMS photographs, and developing a Pseudo GEMS Viewer design concept. The recommended program tasks to accomplish these objectives are described below.

3.1 PSYCHOPHYSICAL GEMS STUDY

The objectives of the Psychophysical GEMS study are the same as outlined originally. However, it is proposed

that an alternate procedure be employed to prepare the matrix. The alternate procedure entails generating GEMS at a photographic scene scale which is a factor of three less than that of mission material, and simulating the appropriate scene scale by means of different microscope optical systems. It is anticipated that the negative GEMS would be viewed at a 20 times magnification and the mission material at a 60 times magnification. The microscope optical performance is not significantly different for the two magnification factors. (It is understood that the customer would supply the optical equipment to be used in the study).

The advantage of this technique approach is that GEMS can be generated at maximum resolutions of 45 lines per millimeter much easier than at 135 lines per millimeter. The scene contrast problem will be eliminated by using already available, unity gamma, negative material. Both a desirable simulated sensitometric curve and modulation transfer function, with an appropriate choice of films and developers, were analytically proven achievable. The realism of grain is obtained by printing the negative GEMS on Type 2401 film. The granularity value of Type 2401 film is approximately three times greater than that of Type 3404.

3.2 EQUAL MAGNIFICATION GEMS

The intent of this task is to explore possible means of generating GEMS photographs which possess the photographic parameters of mission material. This effort will develop the simulation technique of generating GEMS that can be compared with mission material at equal magnifications. It is advantageous to develop this technology, since the GEMS matrix approach may be established as the most advisable simulation technique.

3.3 SYSTEM PARAMETERS

The system parameters to which the GEMS are to be generated are loosely defined. We recommend that a small scale activity be initiated to objectively determine and define the parameters of MTF, contrast, exposure, granularity, density neutrality, and sensitometry. Much of this information may exist at the customer's facility; other parameters that remain undefined will be evaluated with the co-operation of the customer.

3.4 FLIGHT PROGRAM SPECIFICATION

The Equal Magnification GEMS or Pseudo GEMS procedures may require the acquisition of new flight material.

It is the purpose of this task to write up the flight and processing specification in conjunction with the customer.

3.5 PSEUDO GEMS VIEWER DESIGN

The Pseudo GEMS Breadboard activity will continue as outlined in the present study contract alteration, It is recommended that a design concept study, aimed at modifying the GEMS Viewer design, be initiated to establish a Pseudo GEMS Viewer. This activity will be engaged only after successfully demonstrating the principles of the Pseudo GEMS approach.

This image simulation technique appears to hold great promise. If the Pseudo GEMS technique is successful, is is desirable to investigate the material and GEMS Viewer alterations necessary to finalize this particular type evaluation instrument.

4.0 STATEMENT OF WORK

 [redacted] shall provide all of manpower, facilities, services, and materials required to accomplish the program; except where explicitly stated otherwise. The psychophysical experiments and tests are to be performed at the customer's facility with the assistance of the customer's

STATINTL personnel. [redacted] shall provide for the supervision of these experiments and tests by means of a subcontract with

STATINTL [redacted]

4.1 MODIFIED TASKS

The following task work statements of the study program are to be altered as described below.

4.1.1 Psychophysical GEMS Study

A two dimensional GEMS matrix shall be prepared wherein modulation transfer function is varied against exposure. The psychophysical GEMS matrix shall be prepared by an alternate GEMS procedure. The objectives of this study are the same as stated in the original proposal.

4.1.2 Refinement of Technique

Several items in this task have been completed. The following subtasks will be conducted:

(1) Equal Magnification GEMS Study

A study shall be directed toward the development of a GEMS technique which will provide a means of generating equal magnification GEMS to be used in the evaluation of mission material. This study shall encompass the exploration of

conventional and unconventional silver and non-silver photographic systems. A small experimental effort shall be performed on a process that analytically appears feasible.

(2) System Parameter Evaluation

The operational system parameters of MTF, contrast, exposure, granularity, and sensitometry shall be objectively measured and defined. Data from previous evaluation work shall be used whenever applicable, and additional evaluation work shall be performed with the co-operation of the customer's personnel.

(3) Specification of Flight Program

The Equal Magnification GEMS study or the Pseudo GEMS Viewer study may necessitate the acquisition of new original negative material. It is the intent of this task to specify the appropriate processing of such film and to establish a detailed flight plan in coordination with the customer. Such material would be acquired on a future program.

4.1.3 GEMS Viewer

This task has been completed as originally envisioned. However, it is conceived that a Pseudo GEMS Viewer can be fabricated from a modified GEMS Viewer design. Therefore, the task will be extended to encompass the specifying of viewer modifications essential to the control of the image parameters and to specifying the nature of the material to be employed in such a device. The Pseudo GEMS Viewer design concept study will be concluded with the submission of the instrument's specifications and a cost estimate applicable to the detailed design and fabrication of the device.

4.2 UNALTERED TASKS

The following tasks of the study will proceed with no alteration in scope.

(A) Alternate GEMS Technique

(B) Pseudo GEM Breadboard

(C) Liason and Reports

4.3 DELETED TASK

The task, "GEMS Matrix," which involved the generation of a 1000 element matrix, will be deleted from the work statement.

5.0 WORK SCHEDULE

It is proposed that the altered program objectives be accomplished over a nine-month period. The schedule, according to which the individual tasks are to be completed, is presented in bar chart form in Figure 1.

6.0 PROGRAM COST SUMMARY

It has been estimated that the program budget will not be increased by the proposed change of scope. The additional costs to accomplish the proposed tasks are being absorbed by the elimination of the "GEMS Matrix" activity.

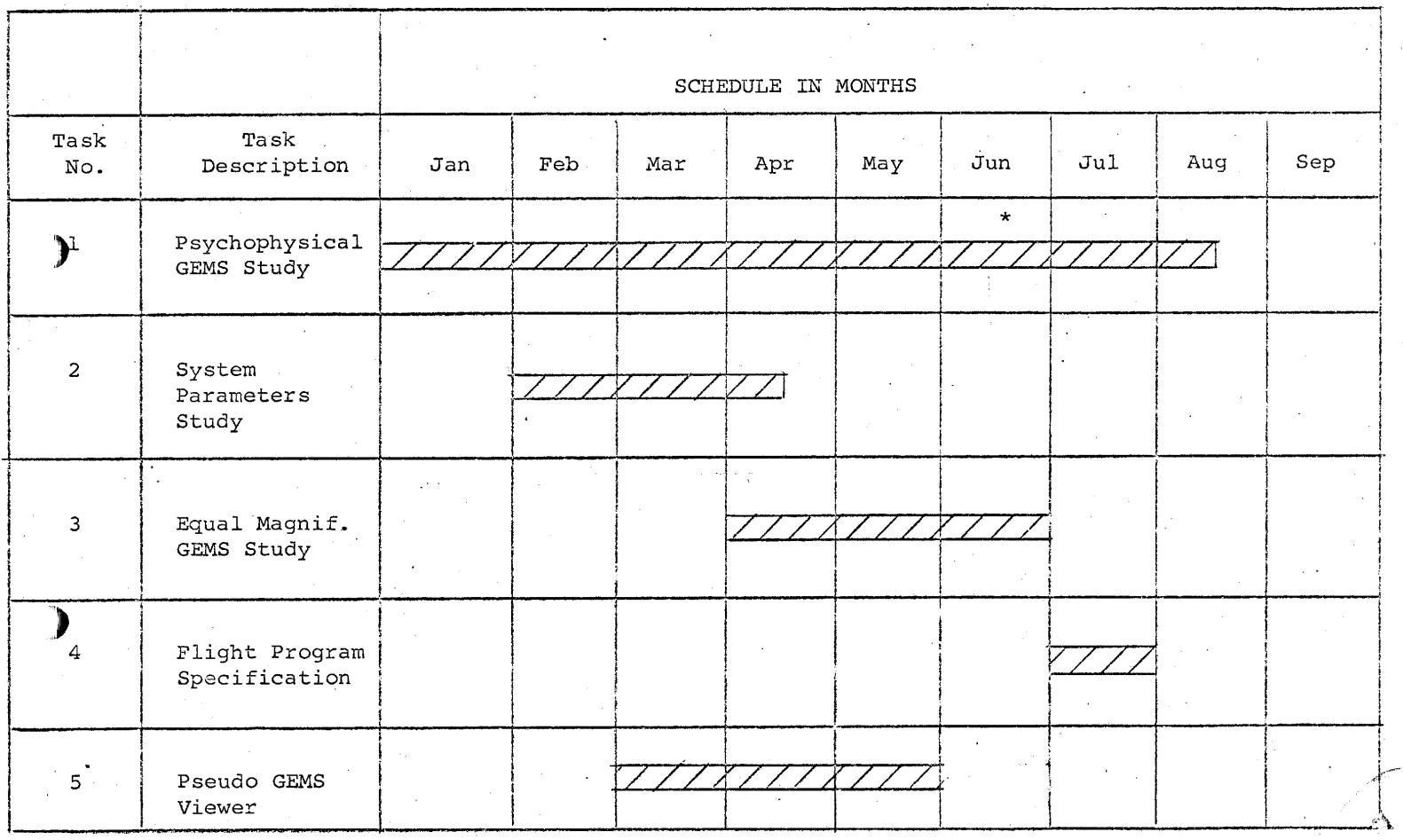

FIGURE 1

* Initiate Psychophysical GEMS tests.

△ Delivery of program final report.

PROGRAM COST SUMMARY SHEET
by Task

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27203 Task No.	Title
10,100	Psychophysical Study
10,200	Refinement of Techniques
20,000	Alternate Technique
30,000	GEMS Viewer Study
40,000	GEMS Matrix
50,000	Project Management
21,000	Pseudo GEMS Breadboard

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PSUEDO-GEMS BREADBOARD & EXPERIMENT

INTRODUCTION

A breadboard and experiment is proposed to determine if a single GEM of a given scene can be altered in a controllable, known manner to simulate other GEMS of the same scene but with differing optical parameters such as haze, MTF, density, etc.

BREADBOARD EQUIPMENT

The experiment consists of a subjective comparison of two GEM images on a ground glass screen. One "low quality" GEM is imaged directly onto the screen thru a Kodak Aero-Ektar lens at f/4. A second GEM, of higher quality is imaged adjacent to the first through an identical lens and through an arrangement that permits the quality of the image to be varied in several aspects (see figure 1).

The beam splitter arrangement allows a varying amount of uniform illumination to be placed in the field to give the effect of contrast reduction. Variation of the aperture stop through the range f/4 to f/16 simulates an approximate 4:1 reduction in the cutoff frequency of the optical system MTF. Provision is made, through variable intensity lamps and interchangeable sets of neutral density filters, to maintain equal illumination of the two images, or to simulate varying net densities.

Finally, other "aberration inputs" may be evaluated by placing simulated wavefront aberrations into the path of the GEM image.

STATEMENT OF WORK

STATINTL [redacted] proposes to furnish the personnel, materials, and facilities to accomplish the following:

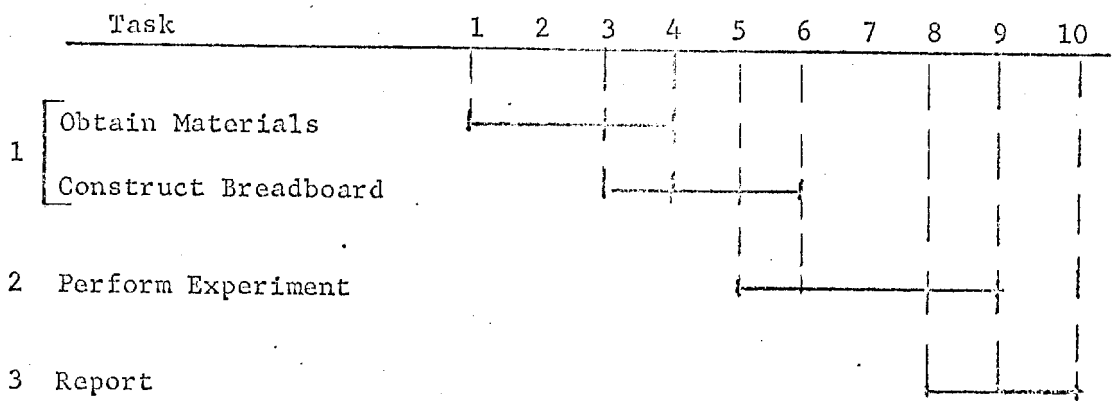
(1) Construct the simple breadboard in accordance with figure 1 and in keeping with the nature of the experiment. Some of the equipment can be obtained on loan from the model shop, to reduce cost.

(2) Conduct an experiment to determine if a high-quality GEM may be degraded in a known, controllable manner to simulate GEMS of lower quality. Check correspondence of different subjects and repeatability of individuals. Investigate each of the degrading factors with respect to limits and interrelationships.

(3) Letter report on the results of Task 2 with recommendations for future work.

PSEUDO-GEM EXPERIMENT

Schedule (Weeks A.R.O.)



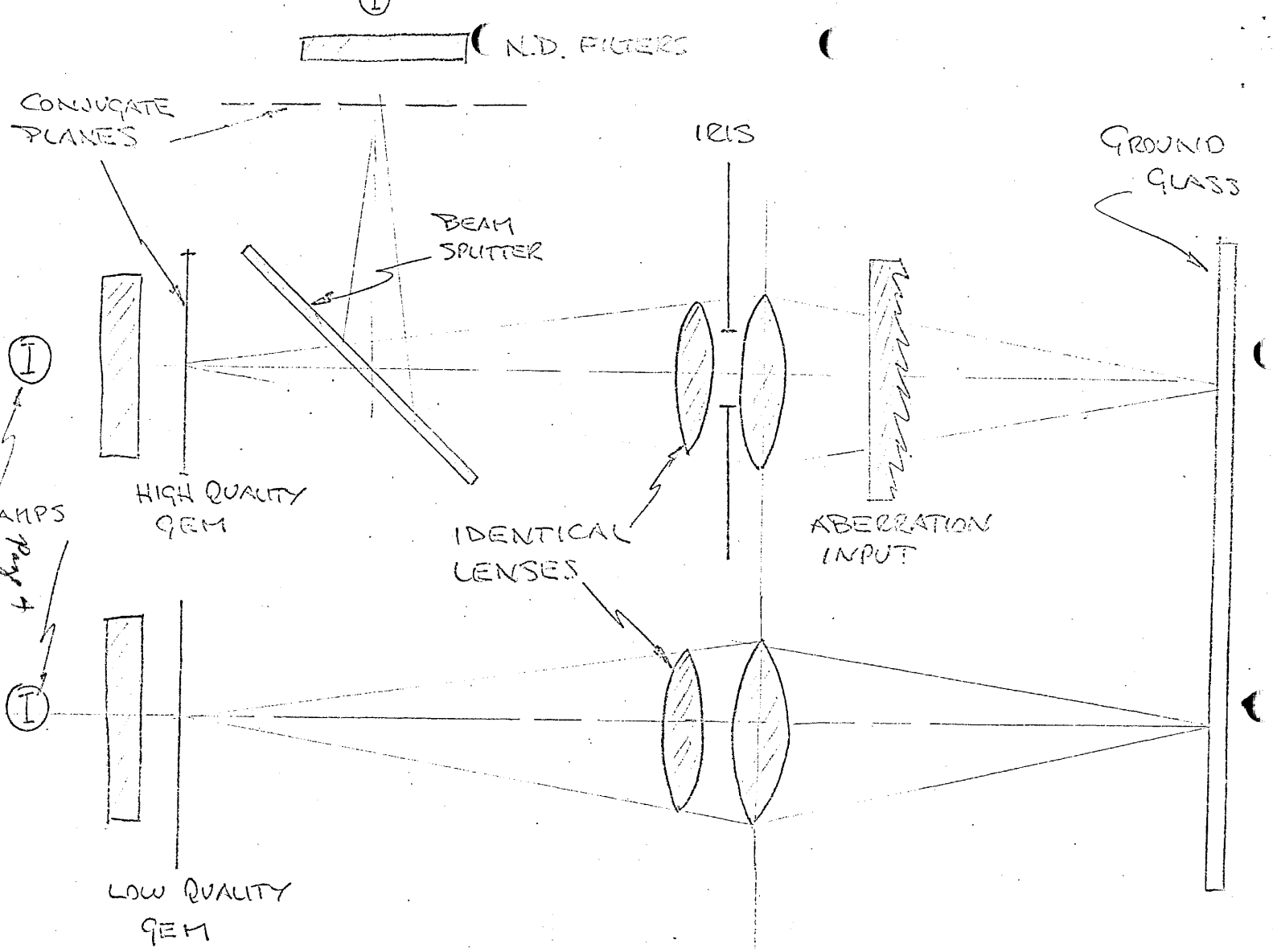
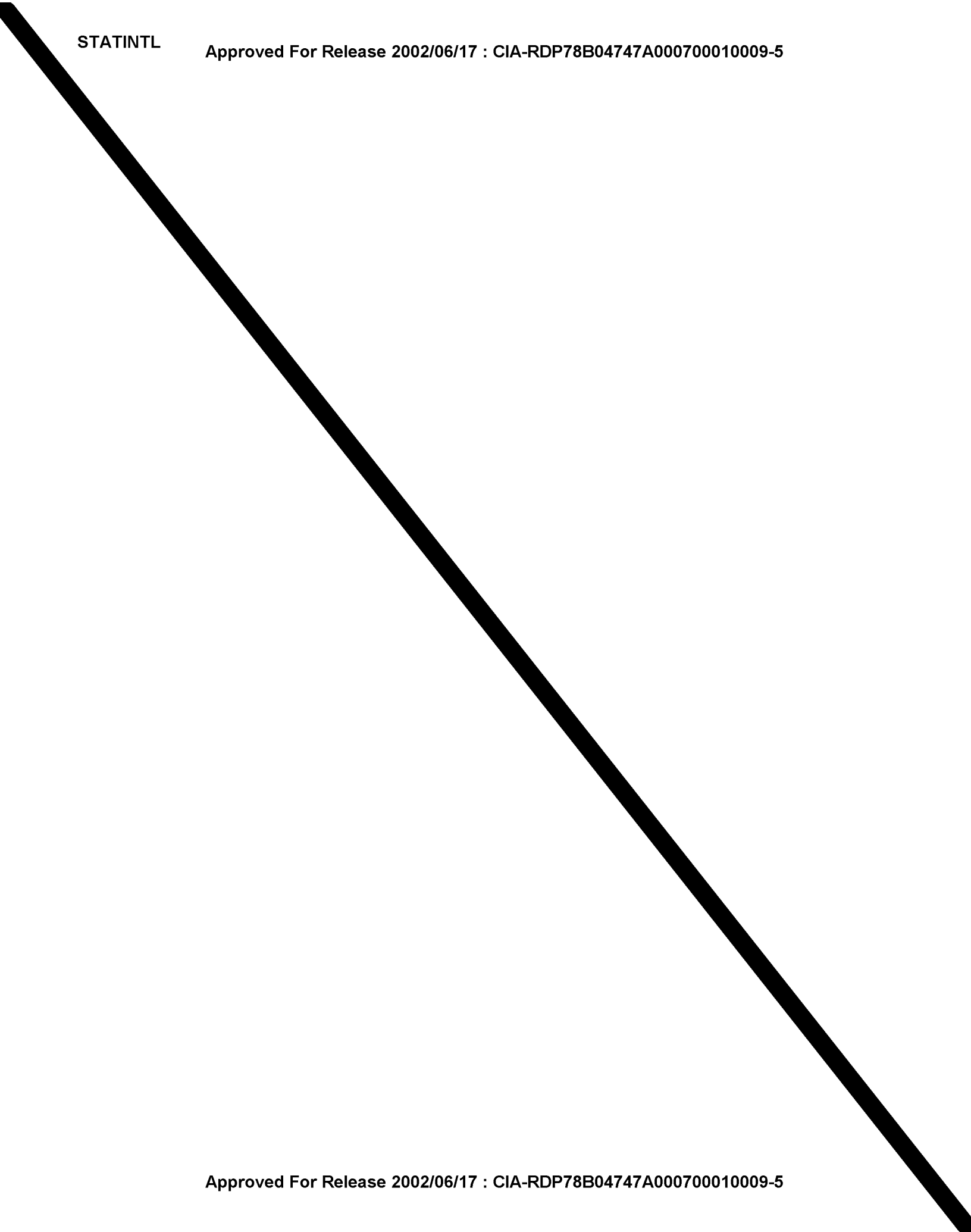


FIGURE 1 – OPTICAL BREADBOARD



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